

8-17-00

A

08/16/00
JCS31 U.S. PTO
09/640809

JCS31 U.S. PTO
09/640809
00/51/80

ASSISTANT COMMISSIONER FOR PATENTS
Washington, D. C. 20231

PATENT APPLICATIONCase Docket No. **199-1721**Date: **8-16-00**

Transmitted herewith for filing is the patent application of Inventor(s):

William Crafts
Mark Aaron
David Jaworski

For: **DIGITALLY ENCODED VEHICLE LAMP SWITCH SYSTEM WITH FAULT TOLERANCE**

Enclosed are:

- ☒ 7 sheet(s) of drawings
☒ Assignment and Cover Sheet
☒ Information Disclosure Statement, PTO Form 1449, and Copies of Citations
☐ A certified copy of

The filing fee has been calculated as shown below for OTHER THAN A SMALL ENTITY:

<u>FOR</u>	<u>NO. FILED</u>	<u>NO. EXTRA</u>	<u>RATE</u>	<u>FEE</u>
Basic Fee				\$ 690
Total Claims	7	0	18	\$ 0
Indep Claims	1	0	78	\$ 0
Multiple Dependent Claims(s)	0		260	\$ 0
Presented				
			TOTAL	\$ 690

- [X] Please charge Deposit Account No. 06-1510 in the amount shown next to the Total.
A duplicate copy of this sheet is enclosed.
- [X] The Commissioner is hereby authorized to charge payment of the following fees associated with this communication or credit any overpayment to Deposit Account No. 06-1510. If there are insufficient funds in this account, please charge the fees to Deposit Account No. 06-1500. A duplicate copy of this sheet is enclosed.
Any additional filing fees required under 37 CFR 1.16.
Any patent application processing fees under 37 CFR 1.17.
- [X] The Commissioner is hereby authorized to charge payment of the following fees during the pendency of this application or credit any overpayment to Deposit Account No. 06-1510. If there are insufficient funds in this account, please charge the fees to Deposit Account No. 06-1500.
Any patent application processing fees under 37 CFR 1.17.
Any filing fees under 37 CFR 1.16 for presentation of extra claims.

"Express Mail"
Mailing Label Number

EL021736793USDate of Deposit **8-16-00**

I hereby certify that this paper or fee is being
deposited with the United States Postal Service
"Express Mail Post Office to Addressee" service
under 37 CFR 1.10 on the date indicated above
and is addressed to the Commissioner of Patent
and Trademarks, Washington, D.C. 20231

(Printed Name of Person Mailing Paper or Fee.)

(Signature of Person Mailing Paper or Fee.)

Jennifer M. Stec
Jennifer M. Stec
Attorney or Agent of Record
Registration No. 35,379
Ford Global Technologies, Inc.
One Parklane Blvd.,
600 Parklane Towers East
Dearborn, MI 48126

Attorney Docket No: 199-1721

Please call 313-322-7762 if this paper becomes separated from the file.

DIGITALLY ENCODED VEHICLE LAMP SWITCH SYSTEM
WITH FAULT TOLERANCE

5 BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to lighting systems for vehicles, and more particularly to an automobile lighting
10 system having a digitally encoded headlamp switch.

2. Background Art

Switching systems for vehicle headlamps are known wherein a main rotary switch is employed to produce control signals to
15 operate load switches.

SUMMARY OF THE INVENTION

A digitally encoded vehicle lamp switch system is provided that supplies signals for controlling the lighting
20 functions of a vehicle. The lamp switch system includes a multi-position switch circuit having a plurality of contacts. The multi-position switch contacts selectively connect a plurality of circuit connections of a vehicle lamp control module microprocessor to ground or open circuit states to
25 provide digitally encoded signals to the microprocessor to selectively illuminate the vehicle lamps.

BRIEF DESCRIPTION OF THE DRAWINGS

The above set forth and other features of the invention
30 are made more apparent in the ensuing Detailed Description of the Invention when read in conjunction with the attached drawings, wherein:

Figure 1 is a schematic circuit diagram of an embodiment of a multi-position vehicle lamp and lighting switch circuit according to the principles of the present invention.

5 Figure 2 is an embodiment of a digital vehicle lamp and lighting system incorporating the multi-position lighting switch circuit of Figure 1 according to the principles of the present invention.

10 Figure 3 is an illustration of a Normal Switch Output Table used in describing the present invention.

15 Figures 4A-D are an illustration of a Fault Logic Chart Table used in describing the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to Figure 1, an embodiment of the digitally encoded headlamp switch system of the present invention is shown that includes a multi-position switch for encoding digital signals that provide lighting functions for the high/low beams of a vehicle's main headlamps, the parking lamps, the front fog lamps, the rear fog lamps, and autolamp with two delay-timed settings. The autolamp functions to turn on the headlights based on ambient light levels. Each delay-timed setting results in a time period during which the headlamps remain illuminated after the ignition has been turned off to provide light for an activity such as entry into a house, for example.

30 The elements FFogInd and RFogInd are LED indicators that illuminate when the front fog lamps or rear fog lamps are on.

35 The ignition switch inputs are not shown in Figure 1 because these elements are not unique to the invention and are known to those skilled in the art.

In the invention, digital code signals are produced on lines M, A, B, C and D by a multi-position switch circuit. The digital code signals on lines M, A, B, C and D correspond to the function provided by the settings of the multi-position switch.

Referring to Figure 3, a Normal Switch Output Table is illustrated wherein a "0" indicates a grounded line and a "1" indicates an open line. "H/L" indicates headlamps, "FF" indicates front fog lamps, "RF" indicates rear fog lamps. "A1" indicates delay-timed setting number 1 and "A2" indicates delay timed setting number 2. "Main" refers to main lamps having high and low beams that are controlled by the multi-function switch. "Park" refers to parking lamps, "Off" designates lamps that are off. There is only one moving contact in the switch, but it makes both the front and rear outputs when in the rear fog position. In Figure 3, numbers 1 through 13 identify the functional digitally encoded switch states.

The Fault Logic Chart Tables illustrated in Figure 4 show the failure mode robustness, that is, the fault tolerance, resulting from the shorted or open lines M, A, B, C, D. The actual function desired is shown as "Headlamp Switch Position." The failure mode wherein a line is permanently shorted or open, is shown as "Circuit State." "Module Sees" shows the resulting digital code from the digital headlamp switch that has the failure. "Module Sees" shows the resulting digital code from the digital headlamp switch that has the failure. "Interpret As" shows the resulting function that has the failure, which includes decode software to default to an even more desirable function for the certain severe failure mode conditions. Shaded blocks in the "Module Sees" column highlight areas where the resulting function that has the failure is different from the intended function. Shaded blocks in the "Interpret As" columns highlight

functions where decode software is compensating for and improving upon the "Module Sees" failure mode condition. The result is an operation shown in the "Interpret As" column that provides the best lighting function alternative that most closely resembles the lighting function selected by the user via the digital headlamp switch.

Additional failure mode robustness, that is, fault tolerance, is designed into the subsystem for high beams and for flash-to-pass (FTP) operation as shown in Figure 4. Activation of the high beams is independent of the lighting control electronics. If a microprocessor failure in the system control module occurs with the lighting control electronics, high beams are nevertheless activated via the high beam relay. Flash-to-pass (FTP) redundancy occurs in that, if the digital headlamp switch and/or the lighting control electronics fail, FTP operation of high and low beams can still be activated via the multi-function switch. FTP operation is independent from both the lighting control electronics and the digital headlamp switch.

Referring to Figure 1, a schematic illustration of a multi-position switch circuit 10 is shown including multi-position main and park light switches 12, 14 and 16 that are ganged together and each having five switch positions; Main, Park, Off, A1 and A2 wherein A1 indicates a delay-timed setting 1 and A2 indicates a delay-timed setting 2.

In the first switch (Main) position, the three switches 12, 14, and 16 respectively connect leads M, A and B to ground 18. In the second (Park) switch position, only the second switch 14 connects lead A to ground 18 while leads M and B are open circuited. In the third (Off) switch position, leads M, A and B are connected to Off and are open circuited. In the fourth (A1) switch position only the third switch 16 connects lead B to ground 18 and leads M and A are open circuited. In

the fifth (A2) switch position, the second switch 14 connects lead A to ground 18 and the third switch 16 connects lead B to bus 16 and lead M is open circuited.

5 The three position Fog switches 20 and 20a having contacts RFog, FFog and Off and are connected to ground 18. In the first position of switch 20 (RFog), ground 18 is connected to a rear fog (RFog) indicator lamp 22 through resistor 24 and lead D is also connected to ground 18. In the
10 second switch position of (FFog) of switches 20, ground 18 is connected to a front fog (FFog) indicator lamp 26 through resistor 28, and lead C is also connected to ground 18. In the third switch position of switch 20, ground 18 is connected to Off and RFog indicator 22, FFog indicator 26, lead C and
15 lead D are open circuited. Switch 20a operates in a similar manner. There is a mechanical interlock between the main and park switches 12, 14 , 16 and fog switches 20 and 20a such that the fog switches 20 and 20a are locked out in the Off position.

20 In the present embodiment, an open circuit line condition is a digital "1" and a grounded line condition is a "0". Thus, in the first switch position (Main) lines M, A and B are connected to ground and lines C and D are open circuited,
25 providing a 00011 condition on leads M,A,B,C and D. In the second switch position (Park) lines M and B are open circuited and line A is grounded, lines C and D are open circuited, providing a 10111.

30 Referring to Figure 3, the Normal Switch Output Table lists the thirteen switch states and the resultant digital signals produced on lines M,A,B, C and D.

35 Referring to Figure 2, a digitally encoded vehicle lamp and lighting switch system is illustrated incorporating the multi-position switch circuit 10 of Figure 1. The M, A and B

lines are connected to a control module block 30 containing a microprocessor 32, a relay driver 34, and an autolamp sensor 36. Microprocessor 32 is connected to Left Lo Beam High Side Driver 38, Right Lo Beam High Side Driver 40. Left Park Lamp High Side Driver 42, and Right Park Lamp High Side Driver 44 are connected to low beam lamp 62, high beam lamp 64, right parking lamps 46 and left parking lamps 48. Microprocessor 32 and Relay Driver 34 are connected to Multifunction-Dimmer Switch 66 on leads 74 and 76. Multifunction-Dimmer switch is a vehicle operator interface control that allows the vehicle operator to select Lo, Hi, or FTP features. The output from Multifunction-Dimmer Switch 66 is connected to actuate high beam relay 68 which in turn is connected along with the signal on lead 76 to actuate high beam lamps 70 and 72. The C and D lines and line 78 from the FFog ind and RFog ind lamps 22 and 26 are connected to Front Fog Lamp Relay 50 and Rear Fog Lamp Relay 52. Front Fog Lamp Relay 50 is connected to Left Front Fog Lamps 54 and 56 and Rear Fog Lamp Relay 52 is connected to Rear Fog Lamps 58 and 60. The signal on lead 78 provides power to the FFogInd 26 and RFogInd 22 when the low beams are activated.

Referring to Figure 3, the Normal Switch Output Table illustrates thirteen states and the corresponding High/Low Switch positions and the digital circuit state that result wherein a digital 0 is created by connection to ground and a digital 1 is created by an open switch condition. Using the Normal Switch Output Table of Figure 3, it is seen how the multi-position switch positions that connect the control module 30 of Figure 2 to ground or open circuit conditions generate a digital code that operates the plurality of lamps designated in Figure 3.

The plurality of switch states for the ten specified failure mode strategies set forth in the Fault Logic Chart of Figures 4A-D are self-explanatory and categorizes all the

conditions and states for the embodiment of the present invention illustrated in Figure 2.

5 While the invention has been described in connection with a preferred embodiment, it is not intended to limit the scope of the invention to the particular form set forth, but, on the contrary, it is intended to cover such alternatives, modifications, and equivalences as may be included within the spirit and scope of the invention as described in the appended
10 claims.

What Is Claimed Is:

1. A digitally encoded switch system for operating a plurality of vehicle lamps comprising:
 - 5 a plurality of vehicle lamps;
 - a multi-position switch circuit having a plurality of selectable switch positions, the multi-position switch circuit being connected to a voltage source and including a plurality of switch contacts for selectively connecting given ones of
 - 10 the switch contacts to the voltage source for creating different open and closed circuit conditions for corresponding positions of the multi-position switch circuit; and
 - a control module including a microprocessor connected to the multi-position switch circuit and to the plurality of vehicle
 - 15 lamps for illuminating selected ones of the vehicle lamps in accordance with the open and closed circuit conditions created by the multi-position switch circuit.
2. The digitally encoded switch system of claim 1 in which the
 - 20 switch contacts of the multi-position switch circuit provide digitally coded signals wherein an open circuit condition manifests a first binary state and a closed circuit condition manifests a second binary state, and wherein the control module microprocessor is responsive to the digitally coded
 - 25 signals manifested by the circuit conditions of the multi-position switch circuit to illuminate selected ones of the vehicle lamps in accordance with the digital code.
3. The digitally encoded switch system of claim 2 wherein the
 - 30 plurality of vehicle lamps include a left low beam headlamp and a left high beam headlamp, a right low beam headlamp and a right high beam headlamp, a left front fog lamp, a right front fog lamp, a left rear fog lamp, a right rear fog lamp, a left park lamp, and a right park lamp.

4. The digitally encoded switch system of claim 2 wherein a relay driver circuit, a multifunction dimmer switch and a relay are connected between the microprocessor and left and right high beam headlamp to selectively illuminate the headlamps in accordance with output signals from the microprocessor.

5. The digitally encoded switch system of claim 2 wherein a left low beam high side driver circuit and a right low beam high side driver circuit are connected between the microprocessor and the left low beam headlamp and right low beam headlamp respectively to selectively illuminate the headlamps in accordance with output signals from the microprocessor.

6. The digitally encoded switch system of claim 2 wherein a front fog lamp relay and a rear fog lamp relay are connected between the multi-position switch circuit and the left front, right front, and left rear, right rear fog lamps respectively to selectively illuminate the fog lamps in accordance with output signals from the microprocessor.

7. The digitally encoded switch system of claim 2 including an autolamp sensor device connected to the control module to provide ambient light information to the control module.

ABSTRACT OF THE INVENTION

A digitally encoded vehicle lamp switch system provided that supplies signals for controlling the lighting functions
5 of a vehicle. The lamp switch system includes a multi-position switch circuit having a plurality of contacts. The multi-position switch contacts selectively connect a plurality of circuit connections of a vehicle lamp control module microprocessor to ground or open circuit conditions to provide
10 digitally encoded signals to the microprocessor to selectively illuminate the vehicle lamps.

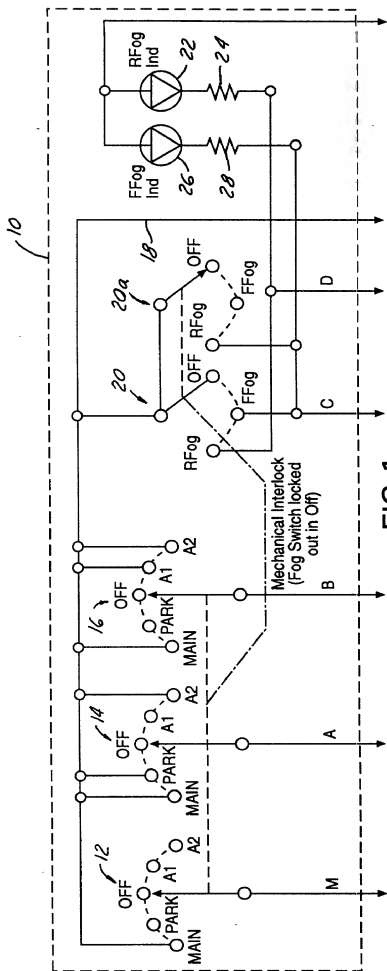


FIG. 1

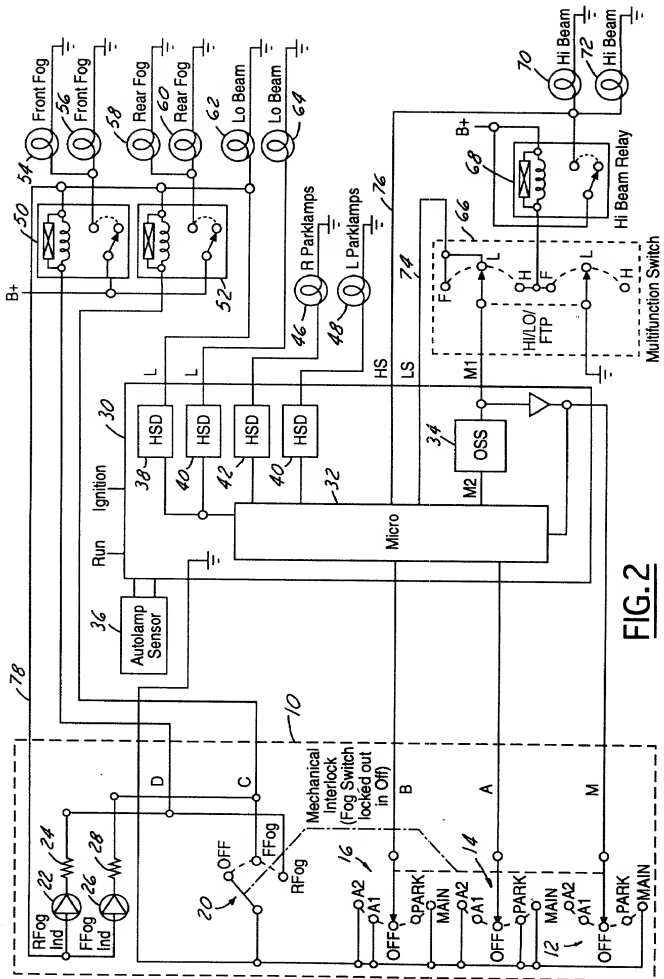


FIG. 2

Normal Switch Output								
	H/L Switch Position			Current State (0=ground, 1=open)				
States	H/L	FF	RF	M	A	B	C	D
1	Main	Off	Off	0	0	0	1	1
2	Main	On	Off	0	0	0	0	1
3	Main	On	On	0	0	0	0	0
4	Park	Off	Off	1	0	1	1	1
5	Park	On	Off	1	0	1	0	1
6	Park	On	On	1	0	1	0	0
7	Off	Off	Off	1	1	1	1	1
8	A1	Off	Off	1	1	0	1	1
9	A1	On	Off	1	1	0	0	1
10	A1	On	On	1	1	0	0	0
11	A2	Off	Off	1	0	0	1	1
12	A2	On	Off	1	0	0	0	1
13	A2	On	On	1	0	0	0	0

FIG. 3

Failure Mode Strategy: Short to Ground on M Circuit															
H/L Switch Position				Circuit State (0=ground, 1=open)				Module Sees				Interpret As			
Switch	H/L	FF	RF	M(0)	A	B	C	D	H/L	FF	RF	H/L	FF	RF	
1	Main	Off	Off	0	0	0	1	1	Main	Off	Off	Main	Off	Off	
2	Main	On	Off	0	0	0	0	1	Main	On	Off	Main	On	Off	
3	Main	On	On	0	0	0	0	0	Main	On	On	Main	On	On	
4	Park	Off	Off	0	0	1	1	1	Main	Off	Off	Main	Off	Off	
5	Park	On	Off	0	0	1	0	1	Main	On	Off	Main	On	Off	
6	Park	On	On	0	0	1	0	0	Main	On	On	Main	On	On	
7	Off	Off	Off	0	1	1	1	1	Main	Off	Off	Off	Off	Off	
8	A1	Off	Off	0	1	0	1	1	Main	Off	Off	Main	Off	Off	
9	A1	On	Off	0	1	0	0	1	Main	On	Off	Main	On	Off	
10	A1	On	On	0	1	0	0	0	Main	On	On	Main	On	On	
11	A2	Off	Off	0	0	0	1	1	Main	Off	Off	Main	Off	Off	
12	A2	On	Off	0	0	0	0	1	Main	On	Off	Main	On	Off	
13	A2	On	On	0	0	0	0	0	Main	On	On	Main	On	On	
Failure Mode Strategy: Short to Ground on A Circuit															
H/L Switch Position				Circuit State (0=ground, 1=open)				Module Sees				Interpret As			
Switch	H/L	FF	RF	M	A(0)	B	C	D	H/L	FF	RF	H/L	FF	RF	
1	Main	Off	Off	0	0	0	1	1	Main	Off	Off	Main	Off	Off	
2	Main	On	Off	0	0	0	0	1	Main	On	Off	Main	On	Off	
3	Main	On	On	0	0	0	0	0	Main	On	On	Main	On	On	
4	Park	Off	Off	1	0	1	1	1	Park	Off	Off	Park	Off	Off	
5	Park	On	Off	1	0	1	0	1	Park	On	Off	Park	On	Off	
6	Park	On	On	1	0	1	0	0	Park	On	On	Park	On	On	
7	Off	Off	Off	1	0	1	1	1	Park	Off	Off	Park	Off	Off	
8	A1	Off	Off	1	0	0	1	1	A2	Off	Off	A2	Off	Off	
9	A1	On	Off	1	0	0	0	1	A2	On	Off	A2	On	Off	
10	A1	On	On	1	0	0	0	0	A2	On	On	A2	On	On	
11	A2	Off	Off	1	0	0	1	1	A2	Off	Off	A2	Off	Off	
12	A2	On	Off	1	0	0	0	1	A2	On	Off	A2	On	Off	
13	A2	On	On	1	0	0	0	0	A2	On	On	A2	On	On	
Failure Mode Strategy: Short to Ground on B Circuit															
H/L Switch Position				Circuit State (0=ground, 1=open)				Module Sees				Interpret As			
Switch	H/L	FF	RF	M	A	B(0)	C	D	H/L	FF	RF	H/L	FF	RF	
1	Main	Off	Off	0	0	0	1	1	Main	Off	Off	Main	Off	Off	
2	Main	On	Off	0	0	0	0	1	Main	On	Off	Main	On	Off	
3	Main	On	On	0	0	0	0	0	Main	On	On	Main	On	On	
4	Park	Off	Off	1	0	0	1	1	A2	Off	Off	A2	Off	Off	
5	Park	On	Off	1	0	0	0	1	A2	On	Off	A2	On	Off	
6	Park	On	On	1	0	0	0	0	A2	On	On	A2	On	On	
7	Off	Off	Off	1	1	0	1	1	A1	Off	Off	A1	Off	Off	
8	A1	Off	Off	1	1	0	1	1	A1	Off	Off	A1	Off	Off	
9	A1	On	Off	1	1	0	0	1	A1	On	Off	A1	On	Off	
10	A1	On	On	1	1	0	0	0	A1	On	On	A1	On	On	
11	A2	Off	Off	1	0	0	1	1	A2	Off	Off	A2	Off	Off	
12	A2	On	Off	1	0	0	0	1	A2	On	Off	A2	On	Off	
13	A2	On	On	1	0	0	0	0	A2	On	On	A2	On	On	

FIG. 4A

Failure Mode Strategy: Short to Ground on C Circuit														
	H/L Switch Position			Circuit State (0=ground, 1=open)					Module Sees			Interpret As		
Switch	H/L	FF	RF	M	A	B	C(0)	D	H/L	FF	RF	H/L	FF	RF
1	Main	Off	Off	0	0	0	0	1	Main	On	Off	Main	On	Off
2	Main	On	Off	0	0	0	0	1	Main	On	Off	Main	On	Off
3	Main	On	On	0	0	0	0	0	Main	On	On	Main	On	On
4	Park	Off	Off	1	0	1	0	1	Park	On	Off	Park	On	Off
5	Park	On	Off	1	0	1	0	1	Park	On	Off	Park	On	Off
6	Park	On	On	1	0	1	0	0	Park	On	On	Park	On	On
7	Off	Off	Off	1	1	1	0	1	Off	On	Off	Off	Off	Off
8	A1	Off	Off	1	1	0	0	1	A1	On	Off	A1	On	Off
9	A1	On	Off	1	1	0	0	1	A1	On	Off	A1	On	Off
10	A1	On	On	1	1	0	0	0	A1	On	On	A1	On	On
11	A2	Off	Off	1	0	0	0	1	A2	On	Off	A2	On	Off
12	A2	On	Off	1	0	0	0	1	A2	On	Off	A2	On	Off
13	A2	On	On	1	0	0	0	0	A2	On	On	A2	On	On
Failure Mode Strategy: Short to Ground on D Circuit														
	H/L Switch Position			Circuit State (0=ground, 1=open)					Module Sees			Interpret As		
Switch	H/L	FF	RF	M	A	B	C	D(0)	H/L	FF	RF	H/L	FF	RF
1	Main	Off	Off	0	0	0	1	0	Main	"1"	"1"	Main	Off	Off
2	Main	On	Off	0	0	0	0	0	Main	On	On	Main	On	On
3	Main	On	On	0	0	0	0	0	Main	On	On	Main	On	On
4	Park	Off	Off	1	0	1	1	0	Park	"1"	"1"	Park	Off	Off
5	Park	On	Off	1	0	1	0	0	Park	On	On	Park	On	On
6	Park	On	On	1	0	1	0	0	Park	On	On	Park	On	On
7	Off	Off	Off	1	1	1	1	0	Off	"1"	"1"	Off	Off	Off
8	A1	Off	Off	1	1	0	1	0	A1	"1"	"1"	A1	Off	Off
9	A1	On	Off	1	1	0	0	0	A1	On	On	A1	On	On
10	A1	On	On	1	1	0	0	0	A1	On	On	A1	On	On
11	A2	Off	Off	1	0	0	1	0	A2	"1"	"1"	A2	Off	Off
12	A2	On	Off	1	0	0	0	0	A2	On	On	A2	On	On
13	A2	On	On	1	0	0	0	0	A2	On	On	A2	On	On

FIG. 4B

Failure Mode Strategy: Open Circuit on M Circuit															
	H/L Switch Position			Circuit State (0=ground, 1=open)				Module Sees			Interpret As				
Switch	H/L	FF	RF	M(1)	A	B	C	D	H/L	FF	RF	H/L	FF	RF	
1	Main	Off	Off	1	0	0	1	1	A2	Off	Off	A2	Off	Off	
2	Main	On	Off	1	0	0	0	1	A2	On	Off	A2	On	Off	
3	Main	On	On	1	0	0	0	0	A2	On	On	A2	On	On	
4	Park	Off	Off	1	0	1	1	1	Park	Off	Off	Park	Off	Off	
5	Park	On	Off	1	0	1	0	1	Park	On	Off	Park	On	Off	
6	Park	On	On	1	0	1	0	0	Park	On	Off	Park	On	Off	
7	Off	Off	Off	1	1	1	1	1	Off	Off	Off	Off	Off	Off	
8	A1	Off	Off	1	1	0	1	1	A1	Off	Off	A1	Off	Off	
9	A1	On	Off	1	1	0	0	1	A1	On	Off	A1	On	Off	
10	A1	On	On	1	1	0	0	0	A1	On	On	A1	On	On	
11	A2	Off	Off	1	0	0	1	1	A2	Off	Off	A2	Off	Off	
12	A2	On	Off	1	0	0	0	1	A2	On	Off	A2	On	Off	
13	A2	On	On	1	0	0	0	0	A2	On	On	A2	On	On	
Failure Mode Strategy: Open Circuit on A Circuit															
	H/L Switch Position			Circuit State (0=ground, 1=open)				Module Sees			Interpret As				
Switch	H/L	FF	RF	M	A(1)	B	C	D	H/L	FF	RF	H/L	FF	RF	
1	Main	Off	Off	0	1	0	1	1	Main	Off	Off	Main	Off	Off	
2	Main	On	Off	0	1	0	0	1	Main	On	Off	Main	On	Off	
3	Main	On	On	0	1	0	0	0	Main	On	On	Main	On	On	
4	Park	Off	Off	1	1	1	1	1	Off	Off	Off	Off	Off	Off	
5	Park	On	Off	1	1	1	0	1	Off	On	Off	Off	Off	Off	
6	Park	On	On	1	1	1	0	0	Off	On	Off	Off	Off	Off	
7	Off	Off	Off	1	1	1	1	1	Off	Off	Off	Off	Off	Off	
8	A1	Off	Off	1	1	0	1	1	A1	Off	Off	A1	Off	Off	
9	A1	On	Off	1	1	0	0	1	A1	On	Off	A1	On	Off	
10	A1	On	On	1	1	0	0	0	A1	On	On	A1	On	On	
11	A2	Off	Off	1	1	0	1	1	A1	Off	Off	A1	Off	Off	
12	A2	On	Off	1	1	0	0	1	A1	On	Off	A1	On	Off	
13	A2	On	On	1	1	0	0	0	A1	On	On	A1	On	On	
Failure Mode Strategy: Open Circuit on B Circuit															
	H/L Switch Position			Circuit State (0=ground, 1=open)				Module Sees			Interpret As				
Switch	H/L	FF	RF	M	A	B(1)	C	D	H/L	FF	RF	H/L	FF	RF	
1	Main	Off	Off	0	0	1	1	1	Main	Off	Off	Main	Off	Off	
2	Main	On	Off	0	0	1	0	1	Main	On	Off	Main	On	Off	
3	Main	On	On	0	0	1	0	0	Main	On	On	Main	On	On	
4	Park	Off	Off	1	0	1	1	1	Park	Off	Off	Park	Off	Off	
5	Park	On	Off	1	0	1	0	1	Park	On	Off	Park	On	Off	
6	Park	On	On	1	0	1	0	0	Park	On	Off	Park	On	Off	
7	Off	Off	Off	1	1	1	1	1	Off	Off	Off	Off	Off	Off	
8	A1	Off	Off	1	1	1	1	1	Off	Off	Off	Off	Off	Off	
9	A1	On	Off	1	1	1	0	1	Off	On	Off	Off	On	Off	
10	A1	On	On	1	1	1	0	0	Off	On	On	Off	On	On	
11	A2	Off	Off	1	0	1	1	1	Park	Off	Off	Park	Off	Off	
12	A2	On	Off	1	0	1	0	1	Park	On	Off	Park	On	Off	
13	A2	On	On	1	0	1	0	0	Park	On	On	Park	On	On	

FIG. 4C

Failure Mode Strategy: Open Circuit on C Circuit														
	H/L Switch Position			Circuit State (0=ground, 1=open)					Module Sees			Interpret As		
Switch	H/L	FF	RF	M	A	B	C(1)	D	H/L	FF	RF	H/L	FF	RF
1	Main	Off	Off	0	0	0	1	1	Main	Off	Off	Main	Off	Off
2	Main	On	Off	0	0	0	1	1	Main	Off	Off	Main	Off	Off
3	Main	On	On	0	0	0	1	0	Main	"1"	"1"	Main	Off	Off
4	Park	Off	Off	1	0	1	1	1	Park	Off	Off	Park	Off	Off
5	Park	On	Off	1	0	1	1	1	Park	Off	Off	Park	Off	Off
6	Park	On	On	1	0	1	1	0	Park	"1"	"1"	Park	Off	Off
7	Off	Off	Off	1	1	1	1	1	Off	Off	Off	Off	Off	Off
8	A1	Off	Off	1	1	0	1	1	A1	Off	Off	A1	Off	Off
9	A1	On	Off	1	1	0	1	1	A1	Off	Off	A1	Off	Off
10	A1	On	On	1	1	0	1	0	A1	"1"	"1"	A1	Off	Off
11	A2	Off	Off	1	0	0	1	1	A2	Off	Off	A2	Off	Off
12	A2	On	Off	1	0	0	1	1	A2	Off	Off	A2	Off	Off
13	A2	On	On	1	0	0	1	0	A2	"1"	"1"	A2	Off	Off
Failure Mode Strategy: Open Circuit on D Circuit														
	H/L Switch Position			Circuit State (0=ground, 1=open)					Module Sees			Interpret As		
Switch	H/L	FF	RF	M	A	B	C	D(1)	H/L	FF	RF	H/L	FF	RF
1	Main	Off	Off	0	0	0	1	1	Main	Off	Off	Main	Off	Off
2	Main	On	Off	0	0	0	0	1	Main	On	Off	Main	On	Off
3	Main	On	On	0	0	0	0	1	Main	On	Off	Main	On	Off
4	Park	Off	Off	1	0	1	1	1	Park	Off	Off	Park	Off	Off
5	Park	On	Off	1	0	1	0	1	Park	On	Off	Park	On	Off
6	Park	On	On	1	0	1	0	1	Park	On	Off	Park	On	Off
7	Off	Off	Off	1	1	1	1	1	Off	Off	Off	Off	Off	Off
8	A1	Off	Off	1	1	0	1	1	A1	Off	Off	A1	Off	Off
9	A1	On	Off	1	1	0	0	1	A1	On	Off	A1	On	Off
10	A1	On	On	1	1	0	0	1	A1	On	Off	A1	On	Off
11	A2	Off	Off	1	0	0	1	1	A2	Off	Off	A2	Off	Off
12	A2	On	Off	1	0	0	0	1	A2	On	Off	A2	On	Off
13	A2	On	On	1	0	0	0	1	A2	On	Off	A2	On	Off

FIG. 4D

DECLARATION AND POWER OF ATTORNEY - ORIGINAL APPLICATION

Attorney's Docket No.
199-1721

As a below named inventor, I hereby declare:
My residence, post office address and citizenship are as stated below next to my name;

I verily believe I am the original, first and sole inventor or an original, first and joint inventor of the subject matter that is claimed and for which a patent is sought on the invention entitled

DIGITALLY ENCODED VEHICLE LAMP SWITCH SYSTEM WITH FAULT TOLERANCE

the specification of which is attached hereto.

I have reviewed and understand the contents of the specification identified above, including the claims.

I acknowledge my duty to disclose information of which I am aware that is material to the examination of this application in accordance with Section 1.56(a), Title 37 of the Code of Federal Regulations; and

as to application for patents or inventor's certificate on the invention filed in any country foreign to the United States of America, prior to this application by me or my legal representatives or assigns,

☒ no such applications have been filed, or

☐ such applications have been filed as follows

COUNTRY	APPLICATION NO.	DATE OF FILING (day, month, year)	DATE OF ISSUE (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s) or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

(Application Number) (Filing Date) (Status - patented, pending, abandoned)

(Application Number) (Filing Date) (Status - patented, pending, abandoned)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the United States Patent and Trademark Office connected therewith and to act on my behalf before the competent International Authorities in connection with any and all international applications filed by me. (List name and registration number)

Randy W. Tung - 31,311
Jennifer M. Stec - 35,379
Mark S Sparschu - 38,317
Roger L. May - 26,406

Address all correspondence and telephone calls to:

Randy W. Tung
Tung & Associates
838 West Long Lake Road, Suite 120
Bloomfield Hills, MI 48302 Phone: 248-540-4040

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

NAME AND POST OFFICE ADDRESS OF INVENTOR:	RESIDENCE	CITIZENSHIP	SIGNATURE	DATE
David J. Jaworski 5255 Kellen Lane Bloomfield, MI 48302 US	Bloomfield, MI 48302 US	U.S.A	<i>David J. Jaworski</i>	6/21/2000
Mark Christian Aaron 6717 Weathersfield Way Canton, MI 48187 US	Canton, MI 48187 US	U.S.A		
William E. Crafts 5573 Leafwood Court Commerce, MI 48382 US	Commerce, MI 48382 US	U.S.A		

Address all correspondence and telephone calls to:

Randy W. Tung
Tung & Associates
838 West Long Lake Road, Suite 120
Bloomfield Hills, MI 48302 Phone: 248-540-4040

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

NAME AND POST OFFICE ADDRESS OF INVENTOR:	RESIDENCE	CITIZENSHIP	SIGNATURE	DATE
David J. Jaworski 5255 Kellen Lane Bloomfield, MI 48302 US	Bloomfield, MI 48302 US	U.S.A		
Mark Christian Aaron 6717 Weathersfield Way Canton, MI 48187 US	Canton, MI 48187 US	U.S.A	<i>Mark C. Aaron</i>	8-16-00
William E. Crafts 5573 Leafwood Court Commerce, MI 48382 US	Commerce, MI 48382 US	U.S.A		

Address all correspondence and telephone calls to:

Randy W. Tung
 Tung & Associates
 838 West Long Lake Road, Suite 120
 Bloomfield Hills, MI 48302 Phone: 248-540-4040

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

NAME AND POST OFFICE ADDRESS OF INVENTOR:	RESIDENCE	CITIZENSHIP	SIGNATURE	DATE
David J. Jaworski 5255 Kellen Lane Bloomfield, MI 48302 US	Bloomfield, MI 48302 US	U.S.A		
Mark Christian Aaron 6717 Weathersfield Way Canton, MI 48187 US	Canton, MI 48187 US	U.S.A		
William E. Crafts 5573 Leafwood Court Commerce, MI 48382 US	Commerce, MI 48382 US	U.S.A	<i>Will E. Crafts</i>	6/23/00